

Claim Amendments

Claim 1 has been canceled in favor of new Claims 13 and 19 whereby the condition 1 and condition 2 aspects of the invention have been placed in separate claims. The subject matter of Claim 3 has been incorporated in new Claims 13 and 19 and the silicon carbide product produced is defined as a single crystal material as supported by the specification on page 12, lines 6-7.

The subject matter of original Claims 7, 8 and 11 has been represented in the form of new Claims 16-18 and 22-24. The new claims have been amended in order to improve upon the method language of each claim. Entry of the newly presented claims is respectfully requested.

Specification Amendments

The specification has been amended in many places to correct "Atchison" to "Acheson," "Reilly" to "Lely," "attachment" to "sticking" and "deposition" to "phase epitaxy." Further, the incorrect notation of " C_2H_5 " has been deleted in favor of the proper recitation of " C_3H_6 " in a number of paragraphs. Entry of the amendments is respectfully requested.

Drawing Correction

Figure 7 has been corrected to show the proper gas propene " C_3H_6 " instead of the improper notation of ethyl " C_2H_5 ." Approval of the drawing correction is respectfully requested.

Claim Rejection, 35 USC 112

The issues raised with respect to Claims 1 and 2 are believed resolved by the cancellation of these claims in favor of new Claims 13 and 19. In the new claims the language objected to has been avoided. Withdrawal of the rejection is respectfully requested.

Invention

The present invention is directed to a method of manufacturing a single crystal of silicon carbide, by forming a single crystal of silicon carbide on a substrate surface at a temperature of not less than 900°C from an atmosphere containing a silicon carbide feedstock gas comprising at least a silicon source gas and a carbon source gas under the atmospheric condition of the partial pressure (p_s) of the silicon source gas being held constant (at $p_s > 0$) and the partial pressure of the carbon source gas in the atmosphere repeatedly alternating between state $pc1$ present at an interval of time ($tc1$) and the state $pc2$ present at an interval of time ($tc2$) until the single crystal of silicon carbide is completely formed, where $pc1 > pc2$ such that the partial pressure ratio ($pc1/p_s$) falls within the range of 1-10 times the attachment coefficient ratio (S_s/S_c) and the partial pressure ratio ($pc2/p_s$) falls within the range of less than once the attachment coefficient ratio (S_s/S_c).

In a second embodiment of the invention a single crystal of silicon carbide is manufactured by forming a single crystal of silicon carbide on a substrate surface at a temperature of not less than 900°C from an atmosphere containing a silicon carbide feedstock gas comprising at least a silicon source gas and a carbon source gas under the atmospheric condition of the partial pressure (pc) of the carbon source gas being held constant (at $pc > 0$) and the partial pressure of the silicon source gas in the atmosphere repeatedly alternating between state $ps1$ present at an interval of time ($ts1$) and the state $ps2$ present at an interval of time ($ts2$) until the single crystal of silicon carbide is completely formed, where $ps1 < ps2$ such that the partial pressure ratio ($pc/ps1$) falls within the range of 1-10 times the attachment coefficient ratio (S_s/S_c) and the partial pressure ratio ($pc/ps2$) falls within the range of less than once the attachment coefficient ratio (S_s/S_c).

Prior Art Rejection, 35 USC 102

Applicants contend that in view of the amendments to the claims, particularly in the form of new Claims 13 and 19, it is clear that the Arya '947 patent does not anticipate the present invention as claimed in either of its major embodiments. The procedure disclosed in the patent, as is clearly evident from Example I thereof, produces **amorphous** silicon carbide as a product, **not a single crystal** (uniform structure) of silicon carbide as claimed in the embodiments of the invention. Moreover, as to the methods of manufacture of the single crystal silicon carbide of the invention versus the amorphous silicon carbide of the patent, the single crystalline material of the invention can only be obtained when the temperature of deposition is not less than 900° C. Thus, a single crystal product is produced having few defects as a result of the use of periodic variation of partial pressures of reactant gases. On the other hand, in the process of Example I of the patent the temperature of the deposition process was materially less than that of the present invention at 240° C. Because of the lower temperature employed in the patent, amorphous silicon carbide is formed having super-lattice layer structures. It is not clear, however, whether the partial pressure conditions of Arya are the same or different from the partial pressure relationships of the present claims because Arya is silent as to whether the total pressure is constant or not. Clearly, Arya does not anticipate the invention as claimed and withdrawal of the rejection is respectfully requested.

Claim Rejection, 35 USC 103

Claims 1-5 stand rejected based on 35 USC 103 as obvious over Arya in view of Golecki, U. S. Patent 5,225,032. This ground of rejection is respectfully traversed.

Applicants maintain their position with respect to Arya as stated above.

As to Golecki, it is clear that a method of producing silicon carbide is taught by

depositing a single crystalline epitaxial SiC film on a single crystalline Si substrate (See Claim 1, for instance). The method producing a single crystal product involves heating a substrate to a temperature in the range of about 600° C to about 1000° C under a flow of a gaseous stream of a compound containing Si, C and H atoms, thereby depositing a single crystalline SiC film by epitaxy on the substrate. Typical such compounds that may be used are $(\text{CH}_3\text{SiH})_2$ and H_3SiCH_3 . Thus, it is clear that the reference only teaches a technique in which the atomic ratio of Si to C in the precursors to silicon carbide product is kept at 1:1. In contradistinction, as is clear from the description of conditions 1 and 2 in Claims 13 and 19 of the invention, the single crystalline material of the invention is produced by a method in which the partial pressure of pc is held constant while the partial pressure of ps periodically varies in an alternating fashion, or the partial pressure of ps is held constant while the partial pressure of pc periodically varies in an alternating fashion. There is absolutely **no** teaching or suggestion of this important feature of the present invention by the reference.

As to the combination of the two patent references, they can not be properly combined. It is clear that Arya teaches a method of producing an **amorphous** silicon carbide product at a comparatively low temperature, while Golecki teaches a method of producing a **single crystalline**, epitaxial silicon carbide material at a much higher temperature than disclosed in Arya. Moreover, while Golecki requires silicon carbide precursors having a 1:1 Si to C ratio, with absolutely no suggestion of the periodic variation of partial pressure of one of the reactants that forms the single crystalline product, Arya gives no indication if the total pressure of the deposition process is constant or not. Clearly, there is not the slightest suggestion in either patent of conditions 1 and 2 of the invention, wherein one of such must be used if the product of the present invention is to be produced. Obviously, an attempt at combination of the patents does not arrive at the present invention.

As to Claim 6, the combination of Arya and Golecki does not teach the pressure embodiment of the claim. As noted above, Golecki teaches the use of Si, C and H containing compounds in which the ratio of Si to C is 1:1 and **never** varies. On the other hand, there is no indication in Arya of whether the total pressure in a given deposition process is constant or varies. How then is the subject matter of Claim 6 found in the two patents?

Claims 3 and 4 stand rejected based on 35 USC 103(a) as obvious over Arya in view of Nagasawa, U. S. Patent 5,390,626. This ground of rejection is respectfully traversed.

Applicants submit that the two identified patents can be properly combined. While Arya discloses a method of producing amorphous silicon carbide by a comparatively low temperature deposition technique under conditions in which it is not clear whether the total pressure of reacting gases is maintained constant, the silicon carbide product of the patent is formed at relatively high temperatures, i.e., about 800-1000° C, from separate reacting carbon and silicon containing gases under pressure conditions which are merely stated as possibly being "variously changed" (col 3, lines 52-58) with no indication of how the reacting gas pressures are changed. Again, there is no teaching or suggestion in either patent of conducting a deposition process in which either the partial pressure of the Si containing gas or the carbon containing gas is held constant while the partial pressure of the other gas alternately varies from a low pressure to a high pressure, preferably in stated time intervals. Rather, it seems from the reference that if gas pressure is varied in the deposition apparatus of the reference, at least a 1:1 stoichiometry of Si to C in the reacting gases is maintained. Clearly, the combined references do not lead one of skill in the art to the present invention and withdrawal of the rejection is respectfully requested.

Claims 7 and 8 stand rejected based on 35 USC 103(a) as obvious over Arya in view of Golecki, further in view of Sugiyama et al, U. S. Patent 5,964,944. This ground of rejection is respectfully traversed.

Although it is clear that Sugiyama et al discloses the preparation of high purity silicon carbide by a method in which reacting Si and C containing gases build-up SiC on a seed crystals, nevertheless, because as seen above the combined Arya and Golecki patents, which result in different silicon carbide products, one of which is amorphous and the other single crystalline, but not like that of the present invention, do not arrive at the single crystalline silicon carbide material of the present invention, the combined patents therefore do not render method Claims 7 and 8 obvious. Accordingly, withdrawal of the obviousness ground of rejection is respectfully requested.

Claim 12 stands rejected based on 35 USC 103(a) as obvious over Arya in view of Golecki, further in view of Gardner et al, U. S. Patent 3,630,678. This ground of rejection is respectfully traversed.

Although it is clear that Gardner et al discloses the preparation of diamond material by the growth of diamond material on seed crystals of SiC by depositing carbon from ethylene gas on the seed crystals, nevertheless, it is clear from the discussion above that the attempted combination of the Arya and Golecki patents does not enable one of skill in the art to arrive at the single crystal silicon carbide product of this invention and therefore the combined patents do not teach or suggest the deposition of carbon to form diamond on seed crystals of the SiC product of the present invention. Accordingly, withdrawal of the obviousness ground of ground of rejection is respectfully requested.

Restriction Requirement


Restriction has been required between separate groups of inventions identified as I: Claims 1-8 and 12 and II: Claims 9-11. In reply applicants provisionally elect Claims 1-8 and 12 of Group I with traverse.

Applicants traverse the requirement on the basis that the Examiner has only concluded that the indicated inventions are separate and distinct versus not having presented evidence that clearly shows them to be separate and distinct. Moreover, a complete search of the relevant prior art only involves two subclasses, so that an undue search burden would not seem to be placed on the Examiner to consider all aspects of the invention in this application. Withdrawal of the restriction requirement is respectfully requested.

It is now believed that the application is in proper condition for allowance. Early notice to this effect is earnestly solicited.

Respectfully submitted,

OBLON, SPIVAK, McCLELLAND,
MAIER & NEUSTADT, P.C.



Norman F. Oblon
Attorney of Record
Registration No.: 24,618

Frederick D. Vastine, Ph.D.
Registration No.: 27,013



22850

TEL: 703-413-3000
FAX: 703-413-2220

DOCKET NUMBER: 209291US0
SERIAL NUMBER: 09/867,467

MAR 04 2003

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MAR 07 2003
TC 1700

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IN THE SPECIFICATION

Please delete the last full paragraph on page 1 of the specification in favor of the following new paragraph:

-- Methods of manufacturing silicon carbide include reacting coke and silicon on a heated carbon surface and precipitating silicon carbide on a carbon surface (the [Atchison] Acheson method); heating and sublimating silicon carbide formed by the [Atchison] Acheson method and recrystallizing it (sublimation method, improved [Reilly] Lely method); the liquid deposition method in which silicon is melted in a carbon crucible and the suspended carbon and silicon are reacted in the crucible while drawing the product upward; and the like. --

Please delete the three full paragraphs on page 2 of the specification in favor of the following new paragraphs:

-- Although the [Atchison] Acheson method produces inexpensive, large quantities of silicon carbide, the precipitating silicon carbide is amorphous, comprising crystalline polymorphism and large quantities of impurities. In particular, this method cannot be employed to manufacture semiconductor materials in which defects and impurities are problematic.

The improved [Reilly] Lely method reduces the problems of crystalline polymorphism, amorphism, and the like associated with the [Atchison] Acheson method. However, it is difficult to reduce the impurities incorporated into the crystal, and increasing the area of the crystal and decreasing the number of defects are no simple tasks.

The method that is generally employed to reduce the crystal defects and impurities that

are problematic in the improved [Reilly] Lely method is to use CVD or ALE to epitaxially grow silicon carbide while reducing the defect density and impurities on a silicon carbide substrate obtained by the improved [Reilly] Lely method. However, since the area of the crystals obtained by these methods is limited to the area of the silicon carbide obtained by the improved [Reilly] Lely method, large-area, high quality silicon carbide cannot be obtained. --

Please delete the paragraph bridging pages 2 and 3 in favor of the following new paragraph:

--To increase the area of silicon carbide, the general method has been devised of using CVD of ALE to heteroepitaxially grow a silicon carbide layer on a single crystal silicon substrate employed as a semiconductor material. However, high concentrations of defects are produced at the interface of the silicon substrate and the silicon carbide. Thus, the quality of the crystal is poorer than that of epitaxially grown silicon carbide layers formed on silicon carbide substrates obtained by the improved [Reilly] Lely method. When employing heteroepitaxial growth, crystal quality can be improved by increasing the thickness of the film of silicon carbide being grown. However, since the rate of silicon carbide growth by CVD of ALE is extremely low, the application of silicon carbide obtained by heteroepitaxial growth is currently impeded. --

Please delete the paragraph of page 4, lines 13-24 of the text in favor of the following new paragraph:

-- the partial pressure p_s of said silicon source gas in said atmosphere is constant (with $p_s > 0$), the partial pressure of said carbon source gas in said atmosphere consists of a state of p_{c1} and a state p_{c2}

(where p_{c1} and p_{c2} denote partial pressures of said carbon source gas, $p_{c1} > p_{c2}$, and the partial pressure ratio (p_{c1}/p_s) falls within a range of 1-10 times the [attachment] sticking coefficient ratio (S_c/S_c), the partial pressure ratio (p_{c2}/p_s) falls within a range of less than one

time the [attachment] sticking coefficient ratio (S_c/S_c)

(where S_c denotes the [attachment] sticking coefficient of silicon source gas to the silicon carbide substrate at the substrate temperature during formation of said silicon carbide, and S_c denotes the [attachment] sticking coefficient of carbon source gas to the silicon carbide substrate at the substrate temperature during the forming of said silicon carbide))--

Please delete the paragraph of page 5, lines 1-12 of the text in favor of the following new paragraph:

-- the partial pressure p_s of said silicon source gas in said atmosphere is constant (with $p_s > 0$), the partial pressure of said carbon source gas in said atmosphere consists of a state of p_{c1} and a state p_{c2}

(where p_{s1} and p_{s2} denote partial pressures of said silicon source gas, $p_{s1} > p_{s2}$, and the partial pressure ratio (p_c/p_{s1}) falls within a range of 1-10 times the [attachment] sticking coefficient ratio (S_c/S_c), the partial pressure ratio (p_c/p_{s2}) falls within a range of less than one time the [attachment] sticking coefficient ratio (S_c/S_c)

(where S_c denotes the [attachment] sticking coefficient of silicon source gas to the silicon carbide substrate at the substrate temperature during formation of said silicon carbide, and S_c denotes the [attachment] sticking coefficient of carbon source gas to the silicon carbide substrate at the substrate temperature during the forming of said silicon carbide))--

Please delete the first two paragraphs of page 6 in favor of the following two new paragraphs:

-- The present invention further relates to a method of manufacturing silicon carbide characterized in that the silicon carbide manufactured in any of Claims 1-6 is employed as seed

crystal and in that silicon carbide is formed on said seed crystal by vapor phase epitaxy, sublimation recrystallization, or liquid [deposition] phase epitaxy.

In the above manufacturing method of silicon carbide, the preferred is that silicon carbide blocks 4-6 inches are formed by vapor phase epitaxy, sublimation recrystallization, or liquid [deposition] phase epitaxy. --

Please delete the first paragraph of page 9 in favor of the following new paragraph:

-- Further, in condition 1, the partial pressure ratio (p_{c1}/p_s) is set to within a range of 1-10 times the [attachment] sticking coefficient ratio (S_c/S_c) and the partial pressure gas ratio (p_{c2}/p_s) is set to within a range of less than one time the [attachment] sticking coefficient ratio (S_c/S_c). Thus, during time t_{c2} when the partial pressure of the carbon source gas is p_{c2} , silicon carbide and Si precipitate simultaneously, and subsequently, during time t_{c1} when the partial pressure of the carbon source gas is p_{c1} , the precipitation of silicon carbide and the formation of silicon carbide through the reaction of precipitated Si and C occur simultaneously. The [attachment] sticking coefficient ratio (S_c/S_c) can be calculated by a method described further below. --

Please delete the first paragraph of page 10 in favor of the following new paragraph:

-- Further, in condition 2, partial pressure ratio (p_c/p_{s1}) is set to within a range of 1-10 times the [attachment] sticking coefficient ratio (S_c/S_c), and partial pressure ratio (p_c/p_{s2}) is set to within a range of less than one time the [attachment] sticking coefficient ratio (S_c/S_c). Thus, during time t_{s2} when the partial pressure of the silicon source gas is p_{s2} , precipitation of silicon carbide and Si occurs precipitate simultaneously, and subsequently, during time t_{s1} when the partial pressure of the silicon source gas is p_{s1} , precipitation of silicon carbide and the formation of silicon carbide through the reaction of precipitated Si and C occur simultaneously. --

Please delete the second paragraph of page 10 in favor of the following new paragraph:

-- [Attachment] Sticking coefficient ratio (S_c/S_c) can be determined in the following

manner. --

Please delete the paragraph bridging pages 10 and 11 in favor of the following new paragraph:

-- Let τ denote the time coordinates of the point of intersection of the tangent of $n(t)$ when $t=0$ and the asymptotic line when $\tau \rightarrow \infty$. Let τ_c (the average residence time of the carbon source gas on the surface of the substrate) denote τ when the gas employed is the carbon source gas. Let τ_s (the average residence time of the silicon source gas on the surface of the substrate) denote τ when the gas employed is the silicon source gas. The [attachment] sticking coefficient ratio can then be calculated from the relation $S_c/S_s = \tau_c / \tau_s$. --

Please delete the first full paragraph of pages 11 in favor of the following new paragraph:

-- During the formation of silicon carbide by the manufacturing method of the present invention, setting the substrate temperature to not less than 900°C promotes the decomposition of molecules adhering to the substrate surface and promotes the reaction, and is suitable from the viewpoint of making it possible to establish a prescribed relation (the relation specified by condition 1 and condition 2) between the partial pressure ratio and the [attachment] sticking coefficient ratio that is independent of the types of gas. The substrate temperature desirable falls with a range of 1,100-1,370°C.--

Please delete the paragraph bridging pages 11 and 12 in favor of the following new paragraph:

-- As shown by Fig. 3 (1), when a silicon source is continuously fed to the substrate surface ($p_s = \text{constant}$, $p_{c2} = 0$), the silicon source thermally decomposes, for example, on the surface of the substrate that has been heated to not less than 900°C and a single crystal of silicon forms on the substrate surface (Fig. 3(2)). Here, when the carbon source is temporarily supplied (at p_{c2}), the formation of the silicon layer on the substrate surface is inhibited and the silicon

layer that formed on the substrate surface prior to the introduction of the carbon source simultaneously reacts with the carbon source, forming silicon carbide (Fig. 3(3)). In this process, when the partial pressure of the carbon source has been set to p_{c2} , the [attachment] sticking coefficient of the carbon source to S_c , the partial pressure of the silicon source to p_s , and the [attachment] sticking coefficient of the silicon source to S_s , and when p_{c2} or p_s is controlled to maintain a relation where p_{c2}/p_s during the carbon source supply is not less than one time and not more than ten times S_s/S_c , the incorporation of the silicon source onto the substrate surface is inhibited during feeding of the carbon source (Fig. 3(4)). --

Please delete the paragraph bridging pages 12 and 13 in favor of the following new paragraph:

-- Although the silicon source gas and the carbon source gas employed in the manufacturing method of the present invention [method] are not specifically limited, at least one member selected from the group consisting of SiH_4 , Si_2H_6 , $SiCl_4$, $SiHCl_3$, SiH_2Cl_2 , $Si(CH_3)_4$, $SiH_2(CH_3)_2$, $SiH(CH_3)_3$ and $Si_2(CH_3)_6$ can be employed as the silicon source gas, for example. Further, at least one member selected from the group consisting of CH_4 , C_3H_8 , $[C_2H_5]_2C_2H_6$, C_2H_2 , C_2H_4 , C_3H_6 , CCl_4 , CHF_3 and CF_4 can be employed as the carbon source gas, for example. --

Please delete the second and third full paragraphs of page 13 in favor of the following new paragraphs:

-- The present invention covers methods of manufacturing silicon carbide characterized in that silicon carbide manufactured by the above-described manufacturing method of the present invention, particularly thin film silicon carbide, is employed as seed crystal, and silicon carbide is formed on this seed crystal by vapor phase epitaxy, sublimation recrystallization, or liquid [deposition] phase epitaxy.

Vapor phase epitaxy, sublimation recrystallization, and liquid [deposition] phase epitaxy

methods for forming silicon carbide are as follows.--

Please delete the third paragraph of page 14 in favor of the following new paragraph:

-- Silicon carbide blocks (for example, ingots and structural members) with bores of from 4-6 inches (ranging from 100-160 mm) can be formed by the above-described manufacturing methods (vapor phase epitaxy, sublimation recrystallization, and liquid [deposition] phase epitaxy). Here, the term "bore" corresponds to the diameter of the substrate employed in the above-described manufacturing methods. In conventional silicon carbide blocks, the bore runs up to about three inches, but based on the manufacturing method of the present invention, silicon carbide blocks with bores of 4-6 inches (equivalent to 102-152 mm, ranging from 100-160 mm) can be obtained. Further, the blocks obtained have planar defect densities of not more than $10^3/\text{cm}^2$. --

Please delete the first paragraph of page 16 in favor of the following new paragraph:

--Employing the $\{101\}$ plane of a single-crystal silicon substrate as the single-crystal growth substrate, the substrate was heated to a temperature of $1,200^\circ\text{C}$, and cubic silicon carbide was epitaxially grown on the upper layer thereof. Using a cold wall type CVD device, the pressure was adjusted through the introduction of Ar to a pressure of 100 mTorr during growth. The growth of silicon carbide on the silicon substrate was conducted by feeding feedstock gases in the form of SiH_2Cl_2 and C_2H_2 . The ratio S_s/S_c of the [attachment] sticking coefficients of SiH_2Cl_2 and C_2H_2 on the surface of the silicon carbide was 0.25.--

Please delete the paragraph bridging pages 16 and 17 in favor of the following new paragraph:

-- Employing the $\{001\}$ plane of a single-crystal silicon substrate as the single-crystal growth substrate, the substrate was heated to a temperature of $1,200^\circ\text{C}$, and 3C-silicon carbide was epitaxially grown on the upper layer thereof. Using a cold wall type CVD device, the pressure

was adjusted through the introduction of Ar to a pressure of 100 mTorr during growth. The growth of silicon carbide on the silicon substrate was conducted by feeding feedstock gases in the form of SiH_2Cl_2 and C_2H_2 . The ratio S_s/S_c of the [attachment] sticking coefficients of SiH_2Cl_2 and C_2H_2 on the surface of the silicon carbide was 0.25. --

Please delete the first paragraph of page 18 in favor of the following new paragraph:

-- Although C_2H_2 was employed as the carbon source and SiH_2Cl_2 as the silicon source in the present embodiment, so long as the partial pressure ratio (flow rate ratio) of the carbon source to the silicon source is not less than once [one time] and not more than ten times the attachment coefficient ratio, at least one member selected from the group consisting of CH_4 , C_3H_8 , $[\text{C}_2\text{H}_5]$, C_2H_6 , C_2H_4 , $[\text{C}_2\text{H}_6]$, C_3H_6 , CCl_4 , CHF_3 and CF_4 can be employed as the carbon source, and at least one member selected from the group consisting of SiH_4 , Si_2H_6 , SiCl_4 , SiHCl_3 , $\text{Si}(\text{CH}_3)_4$, $\text{SiH}_2(\text{CH}_3)_2$, $\text{SiH}(\text{CH}_3)_3$ and $\text{Si}_2(\text{CH}_3)_6$ can be employed as the [carbon] silicon source to achieve the effect of the present invention.--

Please delete the second paragraph of page 18 in favor of the following new paragraph:

-- Employing the {001} plane of a single-crystal silicon substrate as the single-crystal growth substrate, the substrate was heated to a temperature of $1,200^\circ\text{C}$, and 3C-silicon carbide was epitaxially grown on the upper layer thereof. Using a cold wall type CVD device, the pressure was adjusted through the introduction of Ar to a pressure of 100 mTorr during growth. The growth of silicon carbide on the silicon substrate was conducted by feeding feedstock gases in the form of SiH_2Cl_2 and C_2H_2 . The ratio S_s/S_c of the [attachment] sticking coefficients of SiH_2Cl_2 and C_2H_2 on the surface of the silicon carbide was 0.25.--

Please delete the first full paragraph of page 21 in favor of the following new paragraph:

-- Although C_2H_2 was employed as the carbon source and SiH_2Cl_2 as the silicon source in the present embodiment, so long as the partial pressure ratio (flow rate ratio) of the carbon source

to the silicon source is not less than once [one time] and not more than ten times the attachment coefficient ratio, at least one member selected from the group consisting of CH_4 , C_3H_8 , $[\text{C}_2\text{H}_5]$, C_2H_6 , C_2H_4 , $[\text{C}_2\text{H}_5]$, $\underline{\text{C}_3\text{H}_6}$, CCl_4 , CHF_3 and CF_4 can be employed as the carbon source, and at least one member selected from the group consisting of SiH_4 , Si_2H_6 , SiCl_4 , SiHCl_3 , $\text{Si}(\text{CH}_3)_4$, $\text{SiH}_2(\text{CH}_3)_2$, $\text{SiH}(\text{CH}_3)_3$ and $\text{Si}_2(\text{CH}_3)_6$ can be employed as the [carbon] silicon source to achieve the effect of the present invention.--

Please delete the last two paragraphs of page 21 in favor of the following two new paragraphs:

-- Employing the {001} plane of a single-crystal silicon substrate as the single-crystal growth substrate, the substrate was heated to a temperature of $1,300^\circ\text{C}$, and cubic silicon carbide was epitaxially grown on the upper layer thereof. Using a cold wall type CVD device, the pressure was adjusted through the introduction of H_2 to a pressure of 60 mTorr during growth. The growth of silicon carbide on the silicon substrate was conducted by feeding feedstock gases in the form of SiCl_4 and $[\text{C}_2\text{H}_5]$ $\underline{\text{C}_3\text{H}_6}$. The ratio S_s/S_c of the attachment coefficients of SiCl_4 and $[\text{C}_2\text{H}_5]$ $\underline{\text{C}_3\text{H}_6}$ on the surface of the silicon carbide was 0.68.

The embodiment of the present invention will be described based on Fig. 7 below. While continuously feeding SiCl_4 at a flow rate of 20 sccm, $[\text{C}_2\text{H}_5]$ $\underline{\text{C}_3\text{H}_6}$ was intermittently fed to grow silicon carbide. $[\text{C}_2\text{H}_5]$ $\underline{\text{C}_3\text{H}_6}$ was fed 1,000 times at intervals of 5 sec, each time lasting 5 sec. However, the flow rate fc of $[\text{C}_2\text{H}_5]$ $\underline{\text{C}_3\text{H}_6}$ as treated as a parameter and fc_2 was varied from 0.5-200 sccm and the change in silicon carbide growth rate was observed ($fc_1=0$, that is, $pct=0$). --

Please delete the first full paragraph of page 24 in favor of the following new paragraph:

--Although $[\text{C}_2\text{H}_5]$ $\underline{\text{C}_3\text{H}_6}$ was employed as the carbon source and SiCl_4 as the silicon source in the present embodiment, so long as the partial pressure ratio (flow rate ratio) of the carbon source to the silicon source is not less than one time and not more than ten times the

attachment coefficient ratio, at least one member selected from the group consisting of CH_4 , C_3H_8 , C_2H_2 , C_2H_6 , C_2H_4 , $[\text{C}_2\text{H}_6]$ C_3H_6 , CCl_4 , CHF_3 , and CF_4 can be employed as the carbon source, and at least one member selected from the group consisting of SiH_4 , Si_2H_6 , SiH_2Cl_2 , SiHCl_3 , $\text{Si}(\text{CH}_3)_4$, $\text{SiH}_2(\text{CH}_3)_2$, $\text{SiH}(\text{CH}_3)_3$, and $\text{Si}_2(\text{CH}_3)_6$ can be employed as the [carbon] silicon source to achieve the effect of the present invention.--

Please delete the second full paragraph of page 24 in favor of the following new paragraph:

--Employing the {001} plane of a single-crystal silicon substrate as the single-crystal growth substrate, the substrate was heated to a temperature of $1,200^\circ\text{C}$, and cubic silicon carbide was epitaxially grown on the upper layer thereof. Using a cold wall type CVD device, the pressure was adjusted through the introduction of Ar to a pressure of 100 mTorr during growth. The growth of silicon carbide on the silicon substrate was conducted by feeding feedstock gases in the form of SiH_2Cl_2 and C_2H_2 . The ratio S_s/S_c of the [attachment] sticking coefficients of SiH_2Cl_2 and C_2H_2 on the surface of the silicon carbide was 0.25.--

Please delete the first and second full paragraph of page 27 in favor of the following new paragraphs:

-- Although C_2H_2 was employed as the carbon source and SiH_2Cl_2 as the silicon source in the present embodiment, so long as the partial pressure ratio (flow rate ratio) of the carbon source to the silicon source is not less than one time and not more than ten times the attachment coefficient ratio, at least one member selected from the group consisting of CH_4 , C_3H_8 , $[\text{C}_2\text{H}_6]$, C_2H_6 , C_2H_4 , $[\text{C}_2\text{H}_6]$ C_3H_6 , CCl_4 , CHF_3 , and CF_4 can be employed as the carbon source, and at least one member selected from the group consisting of SiH_4 , Si_2H_6 , SiCl_4 , SiHCl_3 , $\text{Si}(\text{CH}_3)_4$, $\text{SiH}_2(\text{CH}_3)_2$, $\text{SiH}(\text{CH}_3)_3$, and $\text{Si}_2(\text{CH}_3)_6$ can be employed as the [carbon] silicon source to achieve the effect of the present invention.

Employing the {001} plane of a single-crystal silicon substrate as the single-crystal growth substrate, the substrate was heated to a temperature of 1,200°C, and cubic silicon carbide was epitaxially grown on the upper layer thereof. Using a cold wall type CVD device, the pressure was adjusted through the introduction of Ar to a pressure of 100 mTorr during growth. The growth of silicon carbide on the silicon substrate was conducted by feeding feedstock gases in the form of SiH_2Cl_2 and C_2H_2 . The ratio S_s/S_c of the [attachment] sticking coefficients of SiH_2Cl_2 and C_2H_2 on the surface of the silicon carbide was 0.25. --

Please delete the paragraph bridging pages 29 and 30 in favor of the following new paragraphs:

--Although C_2H_2 was employed as the carbon source and SiH_2Cl_2 as the silicon source in the present embodiment, so long as the partial pressure ratio (flow rate ratio) of the carbon source to the silicon source is not less than one time and not more than ten times the [attachment] sticking coefficient ratio, at least one member selected from the group consisting of CH_4 , C_3H_8 , $[\text{C}_2\text{H}_5]$, C_2H_6 , C_2H_4 , $[\text{C}_2\text{H}_6]$, C_3H_6 , CCl_4 , CHF_3 , and CF_4 can be employed as the carbon source, and at least one member selected from the group consisting of SiH_4 , Si_2H_6 , SiCl_4 , SiHCl_3 , $\text{Si}(\text{CH}_3)_4$, $\text{SiH}_2(\text{CH}_3)_2$, $\text{SiH}(\text{CH}_3)_3$, and $\text{Si}_2(\text{CH}_3)_6$ can be employed as the [carbon] silicon source to achieve the effect of the present invention.--

Please delete the third full paragraph of page 30 in favor of the following new paragraph:

--In addition to the above-described vapor phase epitaxy, other methods such as sublimation recrystallization and liquid [deposition] phase epitaxy can be employed to form silicon carbide on seed crystal.--

IN THE CLAIMS

Please cancel Claims 1 to 8 and 12 in favor of the following new Claims 13-24:

Claim 13-24. (Newly Added)